European Journal of Education Studies
ISSN: 2501 - 1111
ISSN-L: 2501 - 1111
Available on-line at: www.oapub.org/edu

DOI: 10.46827/ejes.v8i5.3719 Volume 8 | Issue 5 | 2021

THE EFFECT OF JIGSAW INSTRUCTIONAL STRATEGY ON SENIOR SECONDARY SCHOOL STUDENTS' KNOWLEDGE RETENTION IN PHYSICS IN JOS, NIGERIA

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Abstract:
The objective of the study was to determine the effect of jigsaw instructional strategy (JIS) on students' knowledge retention towards physics, based on score levels and gender. The study was a quasi-experimental, pre-test and post-test control group design. Purposive sampling technique was used to select two schools, from which two intact classes of senior secondary school two students in physics were involved in the study. A total of 84 students comprising the experimental and control groups (experimental group = 43; control group = 41) took part in the study. The instrument used for data collection was Physics Retention Test (PRT). The reliability of PRT was ensured using Kuder Richardson formula-21, with a reliability coefficient of 0.79. Four research questions raised in the study were answered using frequency, percentage, mean and standard deviation while the hypotheses formulated were tested using t-test and Analysis of Covariance (ANCOVA) at 0.05 level of significance. The findings from the study showed that JIS improved students' knowledge retention in physics irrespective of gender and score level. It was recommended that teachers should include the use of jigsaw instructional strategy for improving the teaching and learning of physics in Nigeria senior schools.

Keywords: jigsaw instructional strategy, knowledge retention, score level, gender, physics

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1. Introduction

Physics is a branch of science that deals with the study of energy, matter and their interaction (Omosewo, 2009). Physics is a physical science that deals with the fundamental questions on the structure of matter and the interactions of the element constituents of nature that is susceptible to experimental inquiry. There is a close relationship between physics and the four basic needs of man, which includes food, shelter, medical services and security. The objectives of Physics curriculum at the senior secondary school level according to the National Policy on Education (FRN, 2013) include:

1) to provide basic literacy of Physics for functional living in the society,
2) to acquire basic concepts and principles of Physics as preparation for further studies,
3) to acquire scientific skills and attitudes as a preparation for technological applications of Physics, and
4) to stimulate and enhance creativity.

In other to achieve these objectives, guided discovery method was recommended for both teaching and learning of the subject. There is also the need to combat the factors that are considered to be militating against the attainment of the set goals.

These objectives enable students to acquire sufficient proficiency in physics education which will help them to progress as effectively as possible in all subjects in the school curriculum. Physics is a prerequisite for studying any discipline in science (pure and applied), engineering and the environment. These among others underscore the importance of this subject. In Nigeria, physics is offered by students at the senior school level, which is the last three years of senior secondary school (SSS1- SSS3). Despite the importance of physics, the performance of students in the subject has not been encouraging over the years (Damoeroem, 2021). One of the major reasons for this poor performance is the passive traditional method used in teaching and learning physics, these traditional methods include; rote-learning and the conventional lecture method, which are all teacher-centred. These methods are highly dependent on the skills of the teacher and not useful in enhancing learners interpersonal and communication skills. (Macharia, Githua & Mboroki, 2009). Long lectures and dictations, rote learning/memorization and little interaction in the classroom often leave students less attentive and less engaged. Moreover, students in a traditional class have little opportunity to interact with their classmates or their teacher (Arzel, 2012).

Classroom instruction could be active if students spend more time on active forms of learning such as discussions, engaging in activities or team work, instead of spending all their class time listening. Active learning occurs when students are engaged with the subject matter, participate in class activities, collaborate with one another, involved in practical work, ascertain an argument, discover new phenomenon, proffer solutions to problems, and apply a notion to real life situations (Eison, 2010).

Active learning is a process in which learners take the responsibility of their learning and are also given the opportunity to make decisions about different aspects of the learning process (Açıkgöz, 2003). Active learning strategies are instructional techniques which focus on the learner interacting with the subject matter content of a concept through active participation and generation of ideas, rather than being a passive listener and a receiver of knowledge (Salman, 2009). In active learning process, learning no longer remains a standard process (teacher-centred), but changes to a personalized process (student-centred) where the skills of problem-solving, inquiry, critical thinking, discovery and learning to learn are developed (Akinoglu & Tandogan, 2007).

The jigsaw instructional strategy, an active learning strategy is a method of structuring classroom activities to make students dependent on each other to learn. It was originally designed by Aronson (1978) to help weaken racial cliques in integrated schools. Jigsaw is an instructional strategy in which the members of a class are organized into jigsaw (home) groups; the students are then reorganized into expert groups containing one member from each jigsaw group. The members of the expert group work together to learn concepts or solve problems and then return to their jigsaw (home) groups to share their learning. In this way, the work of the expert groups circulates throughout the class, with each person taking responsibility for sharing a piece of the work. The eleven steps to follow in a jigsaw classroom adapted from jigsaw (Aronson, 1978); jigsaw II (Slavin, 1999); and jigsaw IV are highlighted;

1) Students are given the material to be covered to read to introduce and prepare them for the work to be done
2) Students are divided into 5- or 6- person's jigsaw groups. The groups should be diverse in terms of gender, ethnicity, race and ability
3) One student from each group is appointed as the group leader. Other students are also appointed as time-keepers, recorders, and so on
4) The day's lesson is divided into 5-6 subtopics
5) Students are assigned to one subtopic each, students should have direct access only to their own part of the work
6) Students are given time to read over their subtopics at least twice and become familiar with it. There is no need for memorization
7) Temporary expert groups are formed by having one student from each jigsaw group join other students assigned to the same subtopics. Students in these expert groups are given time to discuss the main points or do some calculations in their subtopics and to rehearse the presentations they will make to their jigsaw group. The teacher moves round at this stage to teach the students concepts not well clarified.
8) The students are brought back to their jigsaw groups
9) Each student presents his/her subtopic to the group. Other members of the group are encouraged to ask questions for clarification

10) The instructor/teacher moves from group to group, observing the process. If any group is having trouble, (e.g., a member is dominating or disruptive), the teacher makes an appropriate intervention.
11) At the end of the session, students are evaluated on the main topic, mean evaluation scores of each home group is calculated by the teacher to choose the best group. Groups are rewarded according to their performance after every lesson.

Home/jigsaw groups were formed by the teacher; this is because the group has to be heterogeneous in terms of gender and score level and the teacher is familiar with their score levels. Students in jigsaw and expert groups sit in their groups with seats arranged in circular or square shape, and each student have duties assigned to them, while the teacher facilitates the learning process.

Retention is the ability to retain and consequently remember things experienced or learned by an individual later (Bichi, 2002). Retention of concepts is an important factor in discerning students' achievement in a given problem or assignment, students should be able to retain knowledge from information obtained from lessons in order to benefit from the learning. The teacher's job is not complete until he/she has assisted the learner in retaining knowledge of the information learnt. In order for learners to retain the knowledge of what is being learnt, learners must understand and be able to interpret and apply that which is being learnt. The amount of knowledge retained by learners is directly affected by the extent of original learning and the extent to which students learn originally depends on the instructional strategies used by teachers. This implies that knowledge retention largely depend on the instructional strategies employed by teachers in passing information across to the students. If the learners did not initially learn concepts properly, they will not retain knowledge of the concepts properly either (Olarewaju, 2013). A better retention and recall of what is learnt is achieved when more sense organs are involved and when students see and do things by themselves. Retention of knowledge in learners is directly affected by the amount of drill and practice during the learning process.

Gender equity is a major issue in the on-going reform programs embarked upon by the Federal Government of Nigeria and it is designed to address gender imbalance in education, this is because girls' access to basic education, especially in the northern states of Nigeria has remained low (Salman, 2009). The improved awareness of the significant role of education has brought about increase in school enrolment and literacy level among girls particularly in developing countries, but disparity remains an issue between boys and girls in the study of courses in sciences and technology. One of the goals of any secondary school teacher is to also improve the score level of students and prepare them for further education. The range of marks obtained by students after being subjected to a test refers to their score levels, and is in three categories; (a) high scorers, (b) medium scorers, and (c) low scorers.

2. Purpose of the Study

The purpose of the study was to investigate the effects of jigsaw instructional strategy (JIS) on senior secondary school students' knowledge retention in physics in Jos, Plateau State. Specifically, the study determined:

1) the effect of jigsaw instructional strategy on students' knowledge retention in senior school physics;
2) if gender influences the knowledge retention of senior school students when they learn physics using jigsaw instructional strategy;
3) if students' score level influence the knowledge retention of senior school students when they learn physics using jigsaw instructional strategy;
4) the interaction effect of score level and gender on the knowledge retention of senior school students when they learn physics using jigsaw instructional strategy.

2.1 Research Questions

The following research questions guided the conduct of the study;

1) What difference exists between the mean retention scores among students that learn physics using jigsaw instructional strategy and those that learn using conventional method?
2) Is there any difference between the mean retention scores among students that learn physics using jigsaw instructional strategy based on gender?
3) Is there any difference between the mean retention scores among students that learn physics using jigsaw instructional strategy based on score level?
4) What is the difference between the mean retention scores among students that learn physics using jigsaw instructional strategy based on score level and gender?

2.2 Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance.

HO_1: There is no significant difference in the mean retention scores among students that learn physics using jigsaw instructional strategy and those taught with conventional method.

HO_2: There is no significant difference in the mean retention scores among students that learn physics using jigsaw instructional strategy based on gender.

HO_3: There is no significant difference in the mean retention scores among students that learn physics using jigsaw instructional strategy based on score level.

HO_4: There is no significant interaction effect of score level and gender on the mean retention scores among students that learn physics using jigsaw instructional strategy.

3. Literature Review

Studies have reported the effects of different forms of pedagogy on retention of knowledge in the process of learning. Tanel and Erol (2008) conducted a study where the effectiveness of the jigsaw learning method and conventional teaching method were compared on achievement and retention in a physics course at the University of Turkey. Students in the experimental group were taught using the jigsaw technique while those in the control group were taught using traditional teaching method. At the end of the treatment, a post-test was administered to determine students' achievement while a delay test was administered four weeks to determine students' retention knowledge in physics. Analysis of data was done using the *t*-test statistics. Results from the study indicated that the post-test and delay test mean scores of the jigsaw group were significantly higher than those of the control group. The experimental students had greater achievement and long-term achievement than those in the control group.

Sahin (2010) investigated the effects of Jigsaw III on achievement and retention, of 71 Turkish sixth-grade students in a Turkish course over a six-week period. Results from the *t*-test analysis indicated that students in the jigsaw group performed better in the achievement test than those in the traditional lecture-based learning group. The jigsaw group also had better retention scores in the delay test than those in the control group.

Tran (2014) investigated the effects of cooperative learning on the achievement and knowledge retention of 110 first year primary education students toward the psychology subject at An Giang University. Students were divided into two groups of 55 each and were taught by the same lecturer. Cooperative learning was employed in teaching students in the experimental group while lecture-based teaching was used in teaching students in the control group. The results showed that students who were instructed using cooperative learning had higher scores in the achievement post-test and knowledge retention tests administered after four weeks than students who were taught using lecture-based teaching.

Chianson, Kurumeh and Obida (2010) also conducted a study on the effect of cooperative learning method and conventional learning method on students' retention level in circle geometry. The study was carried out on senior school two students in the three education zones of Benue State, Nigeria. 358 senior school two students were involved in the study and were divided into experimental and control groups. Retention test instrument was administered four weeks after treatment and *t*-test statistics was used for data analysis. The findings of the study revealed that students who were subjected to the cooperative learning strategy were able to retain knowledge of circle geometry concepts than the students who were taught using the conventional learning approach.

Bilesanmi-Awoderu and Oludipe (2012) conducted a study on the effects of cooperative learning strategies on Nigerian junior secondary students' academic achievement in basic science. The treatments for the study were at two levels; learning together and jigsaw II and conventional lecture method, which was the control group. 120 students obtained from intact classes of three selected junior secondary schools in

South-west Nigeria participated in the study. Achievement Test for Basic Science Students (ATBSS), and Basic Science Anxiety Scale (BSAS) were the instruments used for data collection. Mean, standard deviation and ANCOVA and multiple classification analysis (MCA) were used to analyse the data collected and a delayed post-test was administered two weeks after the experiment.

The results of the study indicated that there were significant main effects of anxiety on the students' post and delayed-post test scores in basic science. There were also significant interaction effects of treatment and anxiety on the academic achievement of students at the post-test and delayed-post-test in favour of the jigsaw group. Jigsaw II and learning together cooperative teaching strategies were found to be more efficient in enhancing students' academic achievement and retention in basic science more than the conventional lecture method.

Duyilemi and Bolajoko (2014) investigated the effects of constructivists' learning strategies on students' achievement and retention in biology in selected senior secondary schools in Owo Local government area of Ondo State. 160 students from two co-educational schools participated in the study where 80 students each were classified into experimental and control groups. The instruments used for the study were biology achievement test, teacher's instructional guide on constructivists' strategies, and instructional guide on conventional method. Analysis of data was done using ANCOVA and multiple classification analysis (MCA). The result obtained showed that there were significant main effects of treatment on students' achievement and retention in favour of the experimental group. Saidou (2013) also found that team teaching was more effective than the conventional teaching in improving students' performance and retention level of students at the republic of Niger. The concern of this study is to find out the effect of jigsaw instructional strategy on the retention of physics concepts based on their score levels and gender.

4. Materials and Methods

This study adopted the quasi-experimental research, of the pre-test, post-test control group. The dependent variables in the study are students' attitude towards physics, achievement in physics and retention of knowledge of physics concepts. The study adopted a 2 x 2 x 3 experimental design, the first 2 represents two groups in the study, experimental group (EG) and the control group (CG), the next 2 represents male and female students, while the last 3 represents high, medium and low scorers in the group. The population of the study was all senior secondary school students in Jos, Nigeria. The target population was the entire senior school two students offering physics in Jos. Senior school two (SS2) students were involved in the study because it is expected that they have covered a greater part of the curriculum, and are familiar with the previous knowledge needed for the selected topic (simple harmonic motion) which is within the syllabus of the SS2 as stated in the Nigerian secondary school curriculum.

Students from two intact classes (one from each participating schools) were involved in the study, with 43 and 41students in the experimental and control groups respectively. Students in the experimental group were classified into three score levels (high, medium, low) based on the results obtained from their senior school one (SS1) third term continuous assessment in physics. Students whose scores fell between 70-100percent were classified as high scorers; students whose scores fell between 50-69percent were classified as medium scorers while students whose scores fell between 0-49percent were classified as low scorers.

Three research instruments were used to obtain data for this study. The researcher-designed Instructional Plans (IP) on the concept of simple harmonic motion for experimental and control groups (EG and CG), Physics Achievement Test (PAT) and Physics Retention Test (PRT). IP was used to instruct experimental group and to teach control group the selected physics concept; simple harmonic motion. Physics Retention Test (PRT) consisted of 20 multiple choice and four theory questions. Each item (multiple choice) have four options lettered A-D with only one correct answer. The test was used in determining the retention knowledge of students on the concept of simple harmonic motion in physics three weeks after physics achievement test (PAT) was done. The physics retention test (PRT) contains the same questions as the physics achievement test (PAT) but in a different arrangement. The reliability of PRT was achieved by administering the test items to a trial testing group of fifty (50) students who were not involved in the research groups. The result obtained was subjected to Kuder-Richardson's formula 21. A reliability coefficient of 0.79 was obtained.

A letter of introduction and consent forms were given to the school authorities and the physics teachers to seek permission to use the school's classrooms and engage the students for this study. The researcher sought the consent of the physics teachers to act as research assistants for this study. All the two physics teachers in the participating schools gave their consent. The researcher also sought the consent of the students by giving them consent form to read and indicate their willingness to participate in the experiment.

5. Results and Discussion

Research Question 1: What difference exists between the mean retention scores among students that learn physics using jigsaw instructional strategy and those that learn using conventional method?

Table 1 revealed that the mean retention score of students that learn physics using conventional method is 16.93 with standard deviation 2.88 while the mean retention score of those that learn physics using jigsaw instructional strategy is 28.98 with standard deviation of 3.89. Therefore, the mean difference of 12.05 is large enough to conclude that students that learn physics using jigsaw instructional strategy has higher mean retention score than those that learnt using conventional method.

Table 1: Mean Retention Scores of Students in the Experimental and Control Groups

Group	*N*	Mean	SD	Mean difference
Experimental	43	28.98	3.89	12.05
Control	41	16.93	2.88	
Total	84			

Hypothesis 1: There is no significant difference in the mean retention scores among students that learn physics using jigsaw instructional strategy and those taught with conventional method.

Table 2 showed the analysis of the retention scores of students in control and experimental groups. The calculated *t*-value of -16.1 was computed with a degree of freedom (1, 82) at 0.05 critical levels. Since *p*-value of 0.00 was less than the alpha value, hypothesis nine was rejected. This means that a significant difference existed in the mean retention scores of students in control ($M = 16.93$, $SD = 2.88$) and experimental ($M = 28.98$, $SD = 3.89$) groups. This implies that students that learn physics using jigsaw instructional strategy had better retention of concepts than their counterparts in the control group ($t(82) = -16.1$; $p < 0.05$).

Table 2: t-test Analysis of the Mean Retention Scores of Students in the Experimental and Control Groups

Group	N	M	SD	T	Df	Sig (2 tailed)	Decision
Experimental	43	28.98	3.89	-16.1	82	0.01	S
Control	41	16.93	2.88				

p<0.05

Research Question 2: Is there any difference between the mean retention scores among students that learn physics using jigsaw instructional strategy based on gender?

Table 3 revealed that the mean student's retention score of male and female students that learn physics using jigsaw instructional strategy were similar since the difference in mean of 0.05 is negligible.

Table 3: Mean Retention Scores of Students in the Experimental Group based on Gender

Gender	N	M	SD	Mean difference
Male	22	29.00	4.36	0.05
Female	21	28.95	3.43	
Total	43			

Hypothesis 2: There is no significant difference in the mean retention scores among students that learn physics using jigsaw instructional strategy based on gender.

The analysis in Table 4, revealed the retention scores of male and female students in the experimental group. The calculated *t*-value of 0.04 with degree of freedom (1, 42) was computed at 0.05 critical levels. Since the calculated significance 0.97 was greater than the critical significance 0.05, hypothesis ten was not rejected. This suggests that there was no significant difference in the mean retention scores of male (M=29.00, SD=4.36) and

female (*M*=28.95, *SD*=3.43) students that learn physics using jigsaw instructional strategy (t (42) = 0.04; p>0.05).

Table 4: t-test Analysis of the Mean Retention Scores of Students in the Experimental Group based on Gender

Gender	N	M	SD	t	Df	Sig (2 tailed)	Decision
Male	22	29.00	4.36	0.04	42	0.97	NS
Female	21	28.95	3.43				

p>0.05

Research Question 3: Is there any difference between the mean retention scores among students that learn physics using jigsaw instructional strategy based on score level?

Table 5 revealed that the difference in mean retention scores between high and medium scorers was 4.85; the difference in mean retention scores between medium and low scorers was 0.72 while the mean retention score difference between high and low scorers was 5.57. The difference between the mean retention scores of high and medium scorers; and high and low scorers that learn physics using jigsaw instructional strategy was large (4.85 and 5.57) while the difference between the mean retention score of medium and low scorers was negligible.

Table 5: Mean Retention Scores of Students in the Experimental Group based on Score Level

Scoring Level	N	M	SD
High	10	32.90	3.45
Medium	21	28.05	3.26
Low	12	27.33	3.17
Total	43		

Hypothesis 3: There is no significant difference in the mean retention scores among students that learn physics using jigsaw instructional strategy based on score level.

Table 6 showed the one-way between groups analysis of covariance conducted to find the influence of score level on students' retention of knowledge in physics. Students' pre-test scores were used as covariate in this analysis. There was significant difference in the mean retention scores of students' that learnt physics using jigsaw instructional strategy based on their score level, $F(2, 39) = 6.18$, $p = 0.01$; hypothesis 3 was therefore rejected. Since there was a significant difference in the score levels of students that learnt physics using JIS, post-hoc analysis was run to determine where the difference between the score levels lies as shown in Table 7. The result indicated that the mean score for the low scoring students (*M*=27.33, *SD*=3.17) was significantly different from high scoring students (*M*=32.90, *SD*=3.45); the mean score for the medium scoring students (*M*=28.05, *SD*=3.26) was significantly different from high scorers (*M*=32.90, *SD*=3.45). Low scoring students did not differ significantly from medium scoring students.

Table 6: One-way ANCOVA Analysis of the Mean Retention Scores of Students in the Experimental Group based on Score Level

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	228.75[a]	3	76.25	7.32	0.01	0.36
Intercept	1962.83	1	1962.83	188.44	0.01	0.83
Pretest	24.29	1	24.29	2.33	0.14	0.06
Score level	128.64	2	64.32	6.18	0.01	0.24
Error	406.23	39	10.42			
Total	36740.00	43				
Corrected Total	634.98	42				

$p < 0.05$

Table 7: Post-hoc Analysis of the Multiple Mean Comparisons using Tukey LSD

(I) Score level	(J) Score level	Mean Difference (I-J)	Std. Error	Sig.
Low	Medium	-0.71	1.19	0.55
	High	-5.57*	1.41	0.00
Medium	Low	0.71	1.19	0.55
	High	-4.85*	1.26	0.00
High	Low	5.57*	1.41	0.00
	Medium	4.85*	1.26	0.00

*indicates a significant difference at 0.05 level.

Research Question 4: What is the difference between the mean retention scores among students that learn physics using jigsaw instructional strategy based on score level and gender?

Table 8 showed the mean of students' retention scores in the experimental group based on score level and gender. The mean difference between the scores of males (M = 27.00, SD = 4.20) and females (M = 27.80, SD = 0.84) in the low score level was 0.80, the mean difference between the scores of males (M = 28.56, SD = 3.91) and females (M = 27.67, SD = 2.81) in the medium score level was 0.99, while the mean difference between the scores of males (M = 32.00, SD = 4.20) and females (M = 34.25, SD = 1.50) in the high score level was 2.25. The mean difference among the high scorers was greater than the mean difference among medium and low scorers.

Table 8: Mean Retention Scores of Students in the Experimental Group based on Score Level and Gender

Score level		M	SD	N
Low	Male	27.00	4.20	7
	Female	27.80	0.84	5
	Total	27.33	3.17	12
Medium	Male	28.56	3.91	9
	Female	27.67	2.81	12
	Total	28.05	3.26	21
High	Male	32.00	4.20	6
	Female	34.25	1.50	4

	Total	32.90	3.45	10
Total	Male	29.00	4.36	22
	Female	28.95	3.43	21
	Total	28.98	3.89	43

Hypothesis 4: There is no significant interaction effect of score level and gender on the mean retention scores among students that learn physics using jigsaw instructional strategy.

Table 9 showed the two by two between-groups analysis of covariance conducted to assess the interaction effect of score level and gender on students' retention in physics. Pre-test scores were used as covariate to control for individual differences. There was no significant interaction effect of score level and gender on students' retention scores, $F(2, 36) = 0.97$, $p > 0.05$. The main effect of score level was statistically significant, $F(2, 36) = 6.36$, $p = 0.01$; the main effect of gender was not statistically significant, $F(2, 36) = 0.52$, $p = 0.47$. These results suggest that males and females had different scores in some of the score level categories. High scoring female students scored significantly higher than their male counterparts.

Table 9: Two-way ANCOVA Analysis of the Achievement Scores of Students in the Experimental Group based on Score Level and Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	250.56[a]	6	41.76	3.91	0.01	0.40
Intercept	1878.96	1	1878.96	175.96	0.01	0.83
Pretest	28.02	1	28.02	2.62	0.11	0.07
Score level	135.86	2	67.93	6.36	0.01	0.26
Gender	5.60	1	5.60	0.52	0.47	0.01
Score level * Gender	20.68	2	10.34	0.97	0.40	0.05
Error	384.42	36	10.68			
Total	36740.00	43				
Corrected Total	634.98	42				

$p > 0.05$

6. Conclusion

The study investigated the effects of jigsaw instructional strategy (JIS) on senior school students' retention in physics. The study concluded that students that learnt physics using JIS had improved achievement and retained knowledge of contents learnt better than those in the control group. The study also concluded that gender did not have influence on the Knowledge retention of students that learnt physics using JIS. The high scoring students retained contents learnt better and longer than the medium and low scoring students respectively. It can therefore be concluded from the study that JIS could be used to guide low, medium and high scoring students in the teaching and learning of physics.

Contributions of this study to the body of knowledge are that JIS would maintain students' knowledge retention of physics overtime if the strategy is used by teachers in the teaching and learning of physics in senior secondary schools.

7. Recommendations

Based on the findings of this study, the following recommendations were considered;

1. JIS is an effective instructional strategy; it should therefore be used to encourage and improve the teaching and learning of physics in senior secondary schools.
2. Physics teachers' emphasis should shift from teacher-centred approach of teaching to active learning strategies such as JIS. JIS should be used to improve students' achievement and retention in physics.
3. Students' of different score levels should be encouraged to use JIS for effective learning; jigsaw groups should consist of high, medium and low scoring students so that they can help each other to learn.
4. Professional bodies like National Teachers' Institute (NTI), Science Teachers' Association of Nigeria (STAN), and Mathematics Association of Nigeria (MAN) should organize seminars and workshops for teachers on how to use JIS for effective teaching and learning process.

Conflict of Interest Statement
There are no conflicts of interest to be declared.

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